

## Methodology

This evaluation involves calculating short-term risks for Uranium-233 in accordance with the methodologies presented in EDF-ER-327. Following this evaluation, consider the overall cumulative impacts to the receptors and determine if modifications to the EDF-ER-327 are required.

## Calculation of Short-term Risk

Similar to EDF-ER-327, this evaluation is conducted based on external and internal radiation exposure. The internal radiation exposure includes both inhalation and ingestion.

### External Radiation Exposure

U-233 emits alpha, beta, and gamma radiation. As a result, this radionuclide could pose an external risk under the exposure scenarios discussed in EDF-ER-327. However, due to the low level of concentration and the ICDF fill materials that shield the beta radiation produced by U-233, it does not contribute to short-term risk from an external exposure standpoint and can be screened from further external consideration. However, U-233 will be considered further for the inhalation and ingestion exposure assessments.

### Internal Radiation Exposure

Additional evaluations were performed to determine the extent of the impact of inhalation and ingestion of waste contaminated with U-233 upon the Total Effective Dose Equivalent (TEDE) for twelve different receptors: the ICDF Landfill Laborer, the ICDF Landfill Visitor, the Evaporation Pond Operator, the Evaporation Pond Visitor, the Treatment Unit Operator, the Treatment Unit Visitor, the CFA Office Worker, the Delivery Driver, the ICDF Office Worker, the INEEL Worker, the INEEL Visitor (fence line), and the Highway 26 Rest Area Visitor.

Detailed receptor dose rate calculations were completed for the Treatment Unit Operator scenario described in EDF-ER-327, which is this project's bounding internal radiation exposure dose rate scenario. The basis for eliminating the other scenarios described in the short term risk EDF as bounding has been provided below.

For both inhalation and ingestion pathways, the Cumulative Effective Dose Equivalent (CEDE) was calculated using the following equation:

$$CEDE = \left[ \frac{C_i \times U_i \times 5000}{ALI_i} \right] \times 158$$

where:

$C_i$  = concentration of the  $i^{\text{th}}$  radionuclide, in  $\mu\text{Ci}/\text{cm}^3$  for inhalation, or  $\mu\text{Ci}/\text{g}$  for ingestion, where:

$\mu\text{Ci}/\text{cm}^3 = Ci/\text{kg} \times 1E+06 \mu\text{Ci}/Ci \times 1E-09 \text{ kg}/\mu\text{g} \times 1E-06 \text{ m}^3/\text{cm}^3 \times 40 \mu\text{g}/\text{m}^3$ , and;

$\mu\text{Ci}/\text{g} = Ci/\text{kg} \times 1E+06 \mu\text{Ci}/Ci \times 1E-03 \text{ kg}/\text{g}$

$U_j$  = Uptake rate for the  $j^{\text{th}}$  pathway, using:  
 $2.8\text{E+}07 \text{ cm}^3/\text{d}$  for inhalation;  $100 \text{ mg/d}$  for ingestion  
200 = work days per year (exposure duration)  
 $\text{ALI}_i$  = Annual Limit of Intake for the  $i^{\text{th}}$  radionuclide, in  $\mu\text{Ci}$  (see Table 2), and;  
5,000 = CEDE per  $\text{ALI}_i$ , in mrem.

**TABLE 2.**  
Annual Limits of Intake for the Isotopes of Interest<sup>1</sup>

Isotope	ALI (Inhalation)	ALI (Ingestion)
U-233	4E-02	1E+01

<sup>1</sup> In choosing the appropriate ALIs for each isotope, the most conservative value was chosen, independent of lung retention factors (e.g., "D" & "Y").

Source of class choice values: <http://www.hps.org/publicinformation/ate/q829.html>

Source of ALI values: <http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/appb/Uranium-233.html>

## Results

### Treatment Unit Operator

The contribution to the inhalation and ingestion dose rates are presented in Table 3, including the percentage of total dose from a cumulative constituent perspective.

**TABLE 3.**  
Landfill Laborer Dose Rates.

Isotope	Inhalation Dose Rate (mrem/yr)	Ingestion Dose Rate (mrem/yr)	Total Dose Rate (mrem/yr)	Percent Of Maximum Total Dose Rate <sup>1</sup>
U-233	4.6E+00	1.6E+00	6.2E+00	4.1E-02

<sup>1</sup> The "Maximum Total Dose Rate" is listed in Table 2-1 of EDF-ER-327 as  $1.5\text{E+}01 \text{ rem/yr}$ .

The detailed calculations used to derive the values tabled above are presented in Appendix A.

### Other Scenarios, A Bounding Scenario Discussion

From Table B-1 of EDF-ER-327, it can be seen that the Treatment Unit Operator scenario is the most conservative in terms of short-term risk. Qualitative comparisons have been made to the bounding Treatment unit Operator scenario for each of the remaining eleven scenarios, and the results are presented in Table 4.

**TABLE 4.**  
Determination of Bounding Nature for All Relevant Scenarios.

Receptor(s)	Limiting Parameter(s) (Relative to Bounding Scenario)	Bounding?	Reason For Bounding / Not Bounding <sup>1</sup>
Landfill Laborer, Landfill Bulldozer Operator, Landfill Truck Driver	N/A	No	Shorter exposure frequency than the Treatment Unit Operator scenario
Evaporation Pond Operator	Source term, exposure duration	No	Source term does not contain the full complement of radionuclides found in the landfill.
			Exposure duration of 10,000 hrs total, vs. 23,700 hrs (2,370 days) for Landfill Laborer.
Evaporation Pond Visitor	Exposure duration	No	Exposure duration of 3 days vs. 2,370 days.
Treatment Unit Operator	Exposure duration	Yes	Longest exposure frequency and intake rates.
ICDF Office Worker	Distance from source	No	Minimum distance of 100 m from source vs. direct contact or < 10 m for laborer.
CFA Office Worker	Distance from source	No	Minimum distance of 4,000 m from source vs. direct contact or < 10 m for laborer.
Delivery Driver	Distance from source, exposure duration	No	Minimum distance of 100 m from source vs. direct contact or < 10 m for laborer.
			Maximum exposure duration of 3,000 hrs vs 23,700 hrs for Landfill Laborer.
INEEL Worker	Exposure duration	No	Exposure duration of 1,200 hrs vs. 23,700 hrs for Landfill Laborer
INEEL Visitor	Exposure duration, distance from source	No	10 Exposure duration of 1,200 hrs vs. 23,700 hrs for Landfill Laborer
			85 m from complex vs. direct contact
ICDF Visitor	Exposure duration	No	Exposure duration of 360 hrs vs. 23,700 hrs for Landfill Laborer
Highway 26 Rest Area Visitor	Distance from source	No	Minimum distance of 4000 m from source vs. direct contact or < 10 m for Landfill Laborer.

<sup>1</sup> See EDF-ER-327 for bounding scenario data.

## **Conclusions**

Based upon the results listed in Table 3, the new concentration of U-233 to the source term results in an insignificant (less than 1%) increase in worker dose rates and can be eliminated from further consideration under the short-term risk scenarios. Consistent with Criterion 6 (page 3-14 of EDF-ER-327), those radionuclides that contribute less than 1% of the total dose may be eliminated from further consideration. As such, it is recommended that no additional modifications be made to EDF-ER-327 .

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## **ENGINEERING DESIGN FILE**

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### **APPENDIX A**

#### **CALCULATION BRIEF**

**DETERMINATION OF DOSE RATE CONTRIBUTION FROM THE NEW  
CONCENTRATION LEVEL OF U-233 AT THE ICDF**

### URANIUM-233 - INHALATION CEDE

New Concentration:  $1.64E+05 \text{ pCi/kg} = 1.64E-07 \text{ Ci/kg}$

$$\begin{aligned}\mu\text{Ci}/\text{cm}^3 &= \text{Ci/kg} \times 1E+06 \mu\text{Ci/Ci} \times 1E-09 \text{ kg}/\mu\text{g} \times 1E-06 \text{ m}^3/\text{cm}^3 \times 40 \mu\text{g/m}^3 \\ &= 1.64E-07 \text{ Ci/kg} \times 1E+06 \mu\text{Ci/Ci} \times 1E-09 \text{ kg}/\mu\text{g} \times 1E-06 \text{ m}^3/\text{cm}^3 \times 40 \mu\text{g/m}^3 \\ &= 6.56E-15 \mu\text{Ci/cm}^3\end{aligned}$$

$$\begin{aligned}CEDE &= \left[ \frac{C_i \times U_i \times 5000}{ALI_i} \right] \times 200d/yr \\ CEDE &= \left[ \frac{6.56E-15 \mu\text{Ci}/\text{cm}^3 \times 2.8E7 \text{ cm}^3/d \times 5000 \text{ mrem}}{4E-02 \mu\text{Ci}} \right] \times 200d/yr\end{aligned}$$

$$CEDE = 4.6E+00 \text{ mrem/yr}$$

### URANIUM-233 - INGESTION CEDE

$$\begin{aligned}\mu\text{Ci/g} &= \text{Ci/kg} \times 1E+06 \mu\text{Ci/Ci} \times 1E-03 \text{ kg/g} \\ &= 1.64E-07 \text{ Ci/kg} \times 1E+06 \mu\text{Ci/Ci} \times 1E-03 \text{ kg/g} \\ &= 1.64E-04 \mu\text{Ci/g}\end{aligned}$$

$$\begin{aligned}CEDE &= \left[ \frac{C_i \times U_i \times 5000}{ALI_i} \right] \times 200d/yr \\ CEDE &= \left[ \frac{1.64E-04 \mu\text{Ci/g} \times .01g/d \times 5000 \text{ mrem}}{1E+01 \mu\text{Ci}} \right] \times 200d/yr\end{aligned}$$

$$CEDE = 1.6E+00 \text{ mrem/yr}$$

TECHNICAL MEMORANDUM

CH2MHILL

## Analysis of Short-Term Risk for the ICDF Landfill and Evaporation Ponds

PREPARED FOR: ICDF Implementation Project

PREPARED BY: CH2M HILL

DATE: April 6, 2004

REVISION: 1

The purpose of this technical memorandum is to evaluate the impact on INEEL CERCLA Disposal Facility (ICDF) short-term risk resulting from additional constituents to the ICDF waste inventory.

### Requirements

For the given soil concentrations, estimate the short-term risk of additional constituents in accordance with the methodology presented in EDF-ER-327, "INEEL CERCLA Disposal Facility Short-Term Risk Assessment".

### Background

The INEEL plans to dispose of remediation wastes at the ICDF. Recent evaluations identified constituents which had not been included in the original design inventory or were included in the original design inventory but it has been found that the soil concentration of each constituent is greater than that of the original design inventory. As such, these constituents were not assigned WAC guideline concentrations or mass limits, or these limits will be revised due to the increased soil concentration.

### Methodology

This evaluation estimates the short-term risk of the inorganic (excluding the radioactive constituent which is presented in a separate technical memo) and organic constituents in accordance with the methodologies presented in EDF-ER-327. Only the Treatment Operator exposure scenario is considered in the evaluation since this scenario produces the worst case risk estimates for the contaminant.

### Calculation of Air Concentrations

The concentration in air due to volatilization of each volatile organic constituent was determined according to Appendix E of EDF-ER-327. The values shown in Table 1 were used to perform these calculations.

**TABLE 1**  
Constants Used to Determine Air Concentrations

Constituent	Dimensionless Henry's Law Constant <sup>a</sup>	Diffusion Coefficient in Air (cm <sup>2</sup> /s) <sup>a</sup>	Diffusion Coefficient in Water (cm <sup>2</sup> /s) <sup>a</sup>
1,2-Dichloroethane	4.8E-02	1.0E-01	9.9E-06
Bromomethane	2.6E-01	7.3E-02	1.2E-05
Styrene	1.1E-01	7.1E-02	8.0E-06
Vinyl Chloride	1.1E+00	1.1E-01	1.2E-06

a. [http://risk.lsd.ornl.gov/homepage/rap\\_tool.shtml](http://risk.lsd.ornl.gov/homepage/rap_tool.shtml)

## Calculation of Risk

The Treatment Operator exposure routes that were evaluated include incidental ingestion, dermal absorption, inhalation of particulates and volatiles, and inhalation of volatile emissions from water. The non-carcinogenic hazard index (HI) and excess lifetime cancer risk (ELCR) of each constituent were calculated for each exposure route. Table 2 shows the soil and air concentrations that were used as a basis for the risk calculations. Table 3 lists the variable values that were used in the calculations and Table 4 lists the constants used.

**TABLE 2**  
Soil and Air Concentrations Used in the Risk Calculations

Constituent	Soil Concentration <sup>a</sup> (mg/kg)	Air Concentration <sup>a</sup> (mg/m <sup>3</sup> )
Bromide	3.6E+00	-
Phosphate	5.7E+00	-
Silicon	1.6E+04	-
Tin	3.0E+00	-
1,2,3,4,6,7,8,9-OCDD	3.4E-07	-
1,2,3,4,6,7,8,9-OCDF	7.0E-08	-
1,2,3,4,6,7,8-HxCDD	2.3E-07	-
1,2,3,4,6,7,8-HxCDF	5.9E-07	-
1,2,3,4,7,8,9-HxCDF	2.9E-09	-
1,2,3,4,7,8-HxCDD	2.1E-08	-
1,2,3,4,7,8-HxCDF	9.6E-06	-
1,2,3,6,7,8-HxCDD	1.6E-07	-
1,2,3,6,7,8-HxCDF	5.0E-07	-
1,2,3,7,8,9-HxCDD	4.6E-07	-
1,2,3,7,8,9-HxCDF	1.1E-09	-

**TABLE 2**  
Soil and Air Concentrations Used in the Risk Calculations

Constituent	Soil Concentration <sup>a</sup> (mg/kg)	Air Concentration <sup>a</sup> (mg/m <sup>3</sup> )
1,2,3,7,8-PeCDD	2.6E-07	-
1,2,3,7,8-PeCDF	4.6E-07	-
2,3,4,6,7,8-HxCDF	7.9E-07	-
2,3,4,7,8-PeCDF	3.1E-06	-
2,3,7,8-TCDD	2.0E-08	-
2,3,7,8-TCDF	2.7E-05	-
1,2-dichloroethane	1.3E-01	5.1E-02
2-nitroaniline	4.6E-02	-
3-nitroaniline	4.6E-02	-
4-nitroaniline	4.6E-02	-
Aroclor-1262	2.4E-02	-
Bromomethane	2.0E-02	2.4E-01
Polyvinyl Chloride	1.3E+01	-
Styrene	2.1E+02	1.5E+02
Vinyl Chloride	6.0E-02	3.3E+00

a. Soil concentrations are based on the total mass of each constituent divided by the total landfill volume of 510,000 yd<sup>3</sup>. The total mass is the sum of the original design inventory mass (if applicable) and additional mass determined from the concentrations provided by BBWI (CN-23 dated February 3, 2004) and an assumed waste volume of 2,500 yd<sup>3</sup> for all of the constituents other than the nitroanilines (based on verbal and email conversation with Jim Curnutt on March 24, 2004). The additional volume for the nitroanilines of 3,500 yd<sup>3</sup> was provided in an email from Doug Gail on January 29, 2004 and represents the expected volume from the V-Tank soils. The CDDs and CDFs were further adjusted by applying toxicity equivalence factors (TEF) to each concentration (see Table 3). The concentration in the landfill and evaporation pond leachate was determined from the adjusted soil concentration for each constituent in accordance with EDF-ER-274. Air concentrations of each of the volatile organic compounds is based on the evaporation pond leachate concentration in accordance with EDF-ER-327, Appendix E.

**TABLE 3**  
Variable Values Used in the Risk Calculations

Constituent	Dermal Absorption Factor <sup>a</sup> (%)	Inhalation RfD <sup>a</sup> (mg/kg-d)	Inhalation Slope Factor <sup>a</sup> (kg-d/mg)	Oral RfD <sup>a</sup> (mg/kg-d)	Oral Slope Factor <sup>a</sup> (kg-d/mg)	Dermal Reference Dose <sup>a</sup> (mg/kg-d)	Dermal Slope Factor <sup>a</sup> (kg-d/mg)	Volatileization Factor <sup>b</sup> (m <sup>3</sup> /kg)	TEF <sup>c</sup>
Bromide	-	-	-	-	-	-	-	-	-
Phosphate	-	-	-	-	-	-	-	-	-
Silicon	-	-	-	-	-	-	-	-	-
Tin	1.0E-03	-	-	6.0E-01	-	6.0E-02	-	-	-
1,2,3,4,6,7,8,9-OCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.001
1,2,3,4,6,7,8,9-OCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.001
1,2,3,4,6,7,8-HxCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.001
1,2,3,4,6,7,8-HxCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.001
1,2,3,4,7,8,9-HpCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.001
1,2,3,4,7,8-HxCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.04
1,2,3,4,7,8-HxCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.01
1,2,3,6,7,8-HxCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.04
1,2,3,6,7,8-HxCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.01
1,2,3,7,8,9-HxCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.04
1,2,3,7,8,9-HxCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.01
1,2,3,7,8-PeCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.5
1,2,3,7,8-PeCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.1
2,3,4,6,7,8-HxCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.01
2,3,4,7,8-PeCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.1
2,3,7,8-TCDD <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	1.0
2,3,7,8-TCDF <sup>c</sup>	3.0E-02	-	1.2E+05	-	1.5E+05	-	3.0E+05	-	0.1
1,2-dichloroethane	1.0E-02	-	9.1E-02	-	9.1E-02	-	9.1E-02	3.9E+03	-
2-nitroaniline	1.0E-02	2.9E-05	-	3.0E-03	-	1.5E-03	-	-	-
3-nitroaniline	1.0E-02	2.9E-04	-	3.0E-04	2.1E-02	2.4E-04	2.6E-02	-	-
4-nitroaniline	1.0E-02	1.1E-03	-	3.0E-03	2.1E-02	2.4E-03	2.6E-02	-	-
Aroclor-1262 <sup>d</sup>	6.0E-02	-	2.0E+00	-	2.0E+00	-	2.2E+00	-	-
Bromomethane	1.0E-02	1.4E-03	-	1.4E-03	-	1.1E-03	-	1.8E+03	-
Polyvinyl Chloride	-	-	-	-	-	-	-	-	-
Styrene	1.0E-02	2.9E-01	-	2.0E-01	-	1.6E-01	-	1.3E+04	-
Vinyl Chloride	1.0E-02	2.9E-02	3.1E-02	3.0E-03	1.4E+00	3.0E-03	1.4E+00	1.0E+03	-

**TABLE 3**  
Variable Values Used in the Risk Calculations

Constituent	Dermal Absorption Factor <sup>a</sup> (%)	Inhalation RfD <sup>a</sup> (mg/kg-d)	Inhalation Slope Factor <sup>a</sup> (kg-d/mg)	Oral RfD <sup>a</sup> (mg/kg-d)	Oral Slope Factor <sup>a</sup> (kg-d/mg)	Dermal Reference Dose <sup>a</sup> (mg/kg-d)	Dermal Slope Factor <sup>a</sup> (kg-d/mg)	Volatilization Factor <sup>b</sup> (m <sup>3</sup> /kg)	TEF <sup>c</sup>
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Note:

- a. [http://risk.lsd.ornl.gov/homepage/rap\\_tool.shtml](http://risk.lsd.ornl.gov/homepage/rap_tool.shtml)
- b. <http://www.epa.gov/Region9/waste/sfund/prg/index.htm>
- c. Risk calculations for the dioxins and furans were based on Toxicity Equivalence Factors as described in "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenz-p-Dioxins and -Dibenzofurans (CDDs and CDFs)", October 1986, USEPA, EPA/625/3-89/016; and "Estimating Exposure to Dioxin-Like Compounds", June 1994, USEPA, EPA/600/6-88/005Ca. This method assumes that 2,3,7,8-TCDD is the most toxic of the CDDs and CDFs and the risks posed by the others are scaled accordingly. Therefore, the 2,3,7,8-TCDD risk values were used for each CDD and CDF.
- d. Values for Aroclor-1260 were used.

**TABLE 4**  
Constant Values Used in the Risk Calculations

Parameter	Units	Treatment Operator Scenario <sup>a</sup>
Body Weight	kg	70
Carcinogenic Averaging Time	yrs	70
Noncarcinogenic Averaging Time	yrs	15
Exposure Frequency	day/yr	200
Exposure Duration	yrs	15
Exposure Time <sup>2</sup>	hr/day	10
Incidental Soil Ingestion Rate	mg/kg	100
Skin Surface Area	cm <sup>2</sup> /day	3300
Dermal Adherence Factor	mg/cm <sup>2</sup>	0.2
Inhalation rate	m <sup>3</sup> /day	28.8
Particulate Emission Factor	m <sup>3</sup> /kg	5.00E+06

a. EDF-ER-327, "INEEL CERCLA Disposal Facility Short-Term Risk Assessment"

## Results and Discussion

Table 5 shows the results for the HIs and Table 6 shows the ELCRs for each of the Treatment Operator exposure routes for each constituent.

**TABLE 5**  
Results of the Hazard Index Calculations

Constituent	Soil Ingestion HQ	Dermal Absorption HQ	Inhalation HQ	Inhalation of Volatile Emissions from Water HQ
Bromide	-	-	-	-
Phosphate	-	-	-	-
Silicon	-	-	-	-
Tin	3.9E-06	2.6E-07	-	-
1,2,3,4,6,7,8,9-OCDD	-	-	-	-
1,2,3,4,6,7,8,9-OCDF	-	-	-	-
1,2,3,4,6,7,8-HxCDD	-	-	-	-
1,2,3,4,6,7,8-HxCDF	-	-	-	-
1,2,3,4,7,8,9-HxCDF	-	-	-	-
1,2,3,4,7,8-HxCDD	-	-	-	-
1,2,3,4,7,8-HxCDF	-	-	-	-
1,2,3,6,7,8-HxCDD	-	-	-	-
1,2,3,6,7,8-HxCDF	-	-	-	-
1,2,3,7,8,9-HxCDD	-	-	-	-
1,2,3,7,8,9-HxCDF	-	-	-	-
1,2,3,7,8-PeCDD	-	-	-	-
1,2,3,7,8-PeCDF	-	-	-	-
2,3,4,6,7,8-HxCDF	-	-	-	-
2,3,4,7,8-PeCDF	-	-	-	-
2,3,7,8-TCDD	-	-	-	-
2,3,7,8-TCDF	-	-	-	-
1,2-dichloroethane	-	-	-	-
2-nitroaniline	1.2E-05	1.6E-06	-	0.0E+00
3-nitroaniline	1.2E-04	9.8E-06	-	0.0E+00
4-nitroaniline	1.2E-05	9.8E-07	-	0.0E+00
Aroclor-1262	-	-	-	-
Bromomethane	1.1E-05	9.0E-07	7.1E-04	<b>1.5E+01</b>
Polyvinyl Chloride	-	-	-	-

**TABLE 5**  
Results of the Hazard Index Calculations

Constituent	Soil Ingestion HQ	Dermal Absorption HQ	Inhalation HQ	Inhalation of Volatile Emissions from Water HQ
Styrene	8.2E-04	6.7E-05	5.1E-03	5.0E+01
Vinyl Chloride	1.6E-05	1.0E-06	1.9E-04	1.1E+01

**TABLE 6**  
Results of the Excess Lifetime Cancer Risk Calculations

Constituent	Soil Ingestion ELCR	Dermal Absorption ELCR	Inhalation ELCR	Inhalation of Volatile Emissions from Water ELCR
Bromide	-	-	-	-
Phosphate	-	-	-	-
Silicon	-	-	-	-
Tin	-	-	-	-
1,2,3,4,6,7,8,9-OCDD	8.5E-09	3.4E-09	-	0.0E+00
1,2,3,4,6,7,8,9-OCDF	1.8E-09	7.0E-10	-	0.0E+00
1,2,3,4,6,7,8-HxCDD	5.7E-09	2.2E-09	-	0.0E+00
1,2,3,4,6,7,8-HxCDF	1.5E-08	5.9E-09	-	0.0E+00
1,2,3,4,7,8,9-HxCDF	7.2E-11	2.9E-11	-	0.0E+00
1,2,3,4,7,8-HxCDD	5.4E-10	2.1E-10	-	0.0E+00
1,2,3,4,7,8-HxCDF	2.4E-07	9.6E-08	-	0.0E+00
1,2,3,6,7,8-HxCDD	4.1E-09	1.6E-09	-	0.0E+00
1,2,3,6,7,8-HxCDF	1.2E-08	4.9E-09	-	0.0E+00
1,2,3,7,8,9-HxCDD	1.2E-08	4.6E-09	-	0.0E+00
1,2,3,7,8,9-HxCDF	2.7E-11	1.1E-11	-	0.0E+00
1,2,3,7,8-PeCDD	6.5E-09	2.6E-09	-	0.0E+00
1,2,3,7,8-PeCDF	1.2E-08	4.6E-09	-	0.0E+00
2,3,4,6,7,8-HxCDF	2.0E-08	7.9E-09	-	0.0E+00
2,3,4,7,8-PeCDF	7.7E-08	3.1E-08	-	0.0E+00
2,3,7,8-TCDD	5.1E-10	2.0E-10	-	0.0E+00
2,3,7,8-TCDF	6.8E-07	2.7E-07	-	0.0E+00
1,2-dichloroethane	1.9E-09	1.2E-10	5.8E-08	9.3E-05
2-nitroaniline	-	-	-	-

3-nitroaniline	1.6E-10	1.3E-11	-	-
4-nitroaniline	1.6E-10	1.3E-11	-	-
Aroclor-1262	8.1E-09	3.6E-09	-	0.0E+00
Bromomethane	-	-	0.0E+00	-
Polyvinyl Chloride	-	-	-	-
Styrene	-	-	0.0E+00	-
Vinyl Chloride	1.4E-08	9.2E-10	3.6E-08	<b>2.1E-03</b>

From the results shown in Table 5 it can be seen that three constituents pose a non-carcinogenic risk ( $HI > 1$ ) from the Inhalation of Volatile Emissions from Water exposure route. Bromomethane, styrene, and vinyl chloride are volatile organic compounds that move readily from the water phase to the air phase with calculated emission rates of  $4.9E-02$  g/s,  $3.1E+01$  g/s, and  $6.88E-01$  g/s (calculations based on the methods presented in EDF-ER-327, Appendix E. The Inhalation of Volatile Emissions from Water route assumes that workers are exposed for 15 years. However, based on the calculated emission rates it was found that the total mass for each of the three constituents would be volatilized in less than a day so the 15 year exposure duration assumption is unreasonable for these contaminants. As a result, the volatile emission HI presented is unreasonably high.

From Table 6 it can be seen that vinyl chloride presents a cancer risk ( $ELCR > 1.0E-04$ ). However, as discussed above, the 15 year exposure duration assumption is unreasonable causing the volatile emission ELCR to be unreasonably high.

Based on the limited mass of bromomethane, styrene, and vinyl chloride that will be available in the ICDF, the true His and ELCRs for the Treatment Operator scenario would be much less than 1 and  $1.0e+06$ , respectively. Therefore, no further evaluation is required under the short term risk scenarios.

## Conclusions

The constituents shown in Table 3 will not add risk to ICDF operations so no further analysis of the contaminant is required under the short-term risk scenarios.

## References

EDF-ER-274, 2002, "Leachate Contaminant Reduction Time Study", Rev 1., Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, 2002.

EDF-ER-327, 2003, "INEEL CERCLA Disposal Facility Short-Term Risk Assessment", Rev 0, Environmental Restoration Program, Idaho National Engineering and Environmental Laboratory, 2003.

EPA 1996, *Superfund Soil Screening Guidance: Users Guide*.

Risk Assessment Information System, [http://risk.lsd.ornl.gov/rap\\_hp.shtml](http://risk.lsd.ornl.gov/rap_hp.shtml)

EPA 1986, "Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs)", USEPA, EPA/625/3-89/016

EPA 1994, "Estimating Exposure to Dioxin-Like Compounds", USEPA, EPA/600/6-88/005Ca

USEPA Region 9 Superfund,  
<http://www.epa.gov/Region9/waste/sfund/prg/otherlinks.htm>

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